The effect of nutrition training for health care staff on learner and patient outcomes in adults: a systematic review and meta-analysis

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ABSTRACT

Background: Nutrition training for health care staff has been prioritized internationally as a key means of tackling malnutrition; however, there is a lack of clear evidence to support its implementation. Systematic reviews in other fields of training for health care staff indicate that training strategies may have a beneficial impact on learner and patient outcomes.

Objectives: We assessed whether nutrition training for health care staff caring for nutritionally vulnerable adults resulted in improved learner and patient outcomes and evaluated the effectiveness of different training strategies.

Design: A systematic review of trials of nutrition training for health care staff was conducted. Six databases were searched with key terms relating to malnutrition and nutrition training. Studies were categorized according to cognitive (didactic teaching), behavioral (practical implementation of skills), and psychological (individualized or group feedback and reflection) training strategies. Where sufficient data were available, meta-analysis was performed according to study design and training strategy. All study designs were eligible. The risk of bias was evaluated in accordance with Cochrane guidance.

Results: Twenty-four studies met the eligibility criteria: 1 randomized controlled trial, 4 nonrandomized controlled trials, 3 quasi-experimental trials, 13 longitudinal pre-post trials, 2 qualitative studies, and 1 cross-sectional survey. Results from a number of low-quality studies suggest that nutrition training for health care staff may have a beneficial effect on staff nutrition knowledge, practice, and attitude as well as patient nutritional intake. There were insufficient data to determine whether any particular training strategy was more effective than the others.

Conclusions: In the absence of high-quality evidence, low-quality studies suggest that nutrition training for health care staff has some positive effects. However, further randomized controlled trials are required to confirm overall efficacy and to explore the impact of training strategies on learner and patient outcomes. *Am J Clin Nutr* doi: 10.3945/ajcn.116.144808.

Keywords: malnutrition, nutrition training, nutritional status, patient outcome, knowledge

INTRODUCTION

Malnutrition has widespread adverse effects on physical, social, and psychological function, and in the presence of illness it is associated with increased morbidity and mortality (1, 2). Malnourished individuals experience longer hospital stays (1, 2) and are more likely to be institutionalized (3–5), and as a result, the costs associated with malnutrition have been estimated as £14 billion, €120 billion, and $432 billion each year in the United Kingdom, Europe, and the United States, respectively. Although the need to improve nutritional care has long been recognized and clinical guidance for the detection and management of malnutrition exists (6), nutritional care is often inadequate (7, 8).

Deficits in nutritional knowledge have been identified in hospital (4) and home care staff (5), and internationally, nutrition training for health care professionals (HCPs) and managers has been prioritized as a means of addressing malnutrition and potentially making significant cost savings across health care settings (9). Although nutrition training was a key component of the successful Dutch multidisciplinary malnutrition strategy (10) and was integral to improving nutritional care in US health care settings (9), it remains unclear if staff training in nutrition is an effective use of limited health care resources.

A number of systematic reviews and meta-analyses have investigated the impact of a variety of interventions designed to support staff in improving the nutritional care of patients or residents, including staff training in nutrition (6–8, 11–14). None of these reviews, however, took into consideration the training strategies used even though training strategies may have a significant impact on learner and patient outcomes (15, 16). Systematic reviews and meta-analyses exploring the impact of HCP training on communication (17), quality improvement (15), and general medicine (16) explicitly categorized

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Abbreviations used: ADL, activities of daily living; AMC, arm muscle circumference; CB, cognitive and behavioral; CBP, cognitive, behavioral, and psychological; CP, cognitive and psychological training; GP, general practitioner; HCP, health care professional; MMSE, Mini–Mental State Exam; NRCT, nonrandomized controlled trial; RCT, randomized controlled trial; SMD, standardized mean difference; TST, triceps skinfold thickness.

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the training strategy and its effects. Commonly used cognitive training strategies that aim to enhance learning and understanding, such as didactic lectures (17), have been found to be consistently ineffective (15, 16, 18). Behavioral and psychological strategies (17) that enable learners to practice and reflect on new skills via interactive seminars and performance feedback, respectively (15, 16), are more likely to be successful (16). Furthermore, utilizing a combination of these training strategies may lead to a greater impact than either can accomplish alone (16, 19).

The first aim of this systematic review was to assess the impact of staff nutrition training on nutritional knowledge, practice, and attitudes in learners and nutritional, functional, and clinical outcomes in nutritionally vulnerable patients. The second aim was to evaluate the effect of different training strategies on learner and patient outcomes.

METHODS

A protocol specifying the research question, search terms, databases to be searched, and details of assessment of risk of bias was developed and agreed on with the project supervisor before starting the review. The protocol was neither registered nor published.

Literature search

A systematic review was performed following the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA Statement (20). Six electronic databases were searched: Medline (1966–2015), EMBASE and EMBASE Classic, Web of Science, Cumulative Index to Nursing and Allied Health Literature, PsycINFO, and the British Nursing Index. Search terms were based on the concepts of malnutrition and nutrition training, such as "malnutrition," "nutrition risk," "weight loss," "nutrition training," and "nutrition education." An example of a full search strategy is provided as an online supplement (**Supplemental Material 1**). Gray literature was not searched; however, hand searching was performed by using the "related citations" function in PubMed. Individual studies were identified in PubMed, and all related citations were scrutinized against the eligibility criteria and cross-referenced to avoid duplication. No limits were set for language or publication date.

Study eligibility

Studies were eligible for inclusion if they were conducted in nutritionally vulnerable adults in any health care setting where nutritional training was provided to health care staff with the aim of improving overall nutritional care. The concepts for each of the 4 population, intervention, control, and outcome elements and the study type are summarized in **Table 1**.

Patient-based training and multicomponent interventions, e.g., nutrition training and an additional intervention, were excluded because they have been investigated previously (13). Studies including pregnant women were excluded. All health care staff were included to reflect the wide range of vocations that receive nutritional training (11). Studies used a wide range of outcomes to investigate the efficacy of nutrition training, and as a result, studies were deemed eligible if they reported ≥1 patient- or learner-based outcome. Although randomized controlled trials (RCTs) are considered the gold standard for evidence, all study designs were considered, because well-designed pre-post studies may provide robust evidence when assessing the impact of interventions aiming to improve nutritional care (21).

TABLE 1
Study eligibility criteria[1]

	Criteria
Population	Adults (≥18 y old); hospital (excluding intensive care), residential, and care home settings
Intervention	Nutrition training for HCPs and care assistants (health care staff) aiming to improve nutritional care for nutritionally vulnerable patients or residents
Control	Routine care or no nutritional training
Outcomes	Learner-based: nutritional knowledge, nutritional practice and attitude to nutrition
	Patient-based: body weight and composition, nutritional intake, malnutrition prevalence, functional status, e.g., physical function (handgrip strength) or cognitive function (MMSE)
Study	No limits on study type

[1] HCP, health care professional; MMSE, Mini–Mental State Exam.

Outcomes

Learner- and patient-based outcomes were separated and analyzed accordingly. Learner-based outcomes included staff nutritional knowledge, nutritional practice (e.g., identification of malnourished or "at-risk" patients, documentation, snack provision, mealtime care) and attitude to nutrition. Patient-related outcomes included weight and body composition [e.g., triceps skinfold thickness (TST), arm muscle circumference (AMC)], dietary intake, malnutrition prevalence [e.g., assessed by the Mini Nutritional Assessment (MNA)], and physical (e.g., muscle strength assessed by handgrip strength) and cognitive function [e.g., assessed by the Mini–Mental State Examination (MMSE)].

Study selection and data extraction

The titles and abstracts of potentially eligible studies were reviewed on the screen by one author (OM). The full texts of potentially eligible studies were read in full and compared against the eligibility criteria. Any uncertainties regarding the selection of studies at the inclusion stage were discussed with the other authors (CB and CEW), and a consensus was reached. All identified studies were collated by using the data management research tool Mendeley (version 1.13.8; Glyph & Cog, LLC). For all included studies data were independently extracted by OM and CEW on study design, setting, population characteristics, outcomes, risk of bias, training teacher, intervention strategy, duration of training, and length of follow-up using a pro forma based on the Cochrane data extraction template (22). Any discrepancies regarding data extraction were discussed by the authors, and a consensus was reached. In the event of lack of data or clarity regarding methods or results, study authors were contacted.

Risk of bias in individual studies

Each study was evaluated for selection, performance, detection, attrition, reporting, and other causes of bias by one author (OM). These criteria were independently judged as having a high, low, or unclear risk of bias by using guidelines from the Cochrane Handbook (23) and the Cochrane Collaboration guidance for assessing quasi-RCTs and controlled pre-post studies (22).

Planned methods of analysis

Studies were subgrouped according to the training strategy used, i.e., cognitive, behavioral, psychological, or a combination (24). Cognitive training strategies aim to increase learner knowledge and to facilitate understanding of nutritional issues in health care staff (i.e., education). Behavioral strategies aim to increase skills in managing nutritional issues and their potential challenges, enabling the learners to practice new skills within the training intervention. Finally, psychological strategies provide opportunities for counseling, mentoring, feedback, and encouraging the expression of thoughts and feelings, allowing learners to reflect on their practice through building self-efficacy, a sense of control, motivation, and empowerment (24).

Statistical analysis

Data were tabulated and categorized according to learner- and patient-based outcomes in structured summaries. Trends in the data were described according to the type of data, the methods used to collect data, and whether the results were statistically significant.

Change in the nutritional knowledge of health care staff was identified as the only outcome where sufficient data were available for meta-analysis. Where studies reported the mean change (SD − SD) in score, these were extracted (25). Where studies reported individual scores for each question according to group allocation, the means ± SDs for correct answers were calculated for each group (26, 27). When studies reported the nutritional knowledge score as a percentage, it was assumed that this referred to the percentage of correct answers, and this was converted to a mean number ± SD (28–30). When SDs of difference were not reported (31), they were calculated by using the reported within-group SEs and CIs or SEs, t values, and P values relating to the differences between groups (23). When these values were not available, SDs were imputed by using values from studies that used similar training strategies (23).

Meta-analysis was undertaken with the use of Review Manager (RevMan version 5.3; Nordic Cochrane Centre) by using a continuous, inverse, fixed-effect analysis. The standardized mean difference (SMD) was used because data were collected by using a variety of different questionnaires (23). Studies were categorized by using subgroup analysis according to whether the results were reported as mean changes ± SDs or as mean scores ± SD pre- and postintervention and according to training strategy. Heterogeneity was defined by using the I^2 statistic in accordance with Cochrane guidance (23). Because studies were heterogeneous for participants, setting, and type of training strategy, as well as small in size, no overall summary of all studies was undertaken.

RESULTS

Study selection

The systematic search identified 24 studies (**Figure 1**), comprising 1 RCT, 4 nonrandomized controlled trials (NRCTs), 3 quasi-experimental trials, 13 longitudinal pre-post trials, 2 qualitative studies, and 1 cross-sectional survey. Study characteristics are provided in **Table 2**, and a list of the excluded studies, together with reasons for exclusion, is provided in **Supplemental Material 2**.

Health care setting and population

Nine studies (28–30, 38, 40, 41, 44, 46, 47) took place in the acute setting, 8 (26, 33, 37, 39, 42, 43, 45, 48) in nursing homes, 5 (25, 31, 32, 34, 36) in the community, and 2 (27, 35) in sheltered accommodation. Sample sizes ranged from 21 to 5571 patients or residents, and from 11 to 592 health care staff. Nine studies included older people (>64 y old) (25, 27, 29, 35, 37, 39, 43, 45, 48), and nurses or nursing assistants were the most commonly targeted staff group for nutrition training (n = 14 studies) (26, 29, 33, 34, 38–47).

Intervention characteristics

Five studies used cognitive training strategies alone (25, 26, 32–34). No studies used behavioral or psychological strategies alone. The most common training strategy used was a combination of cognitive and behavioral (CB) strategies (n = 7) (27, 29, 35–39). Six studies used cognitive and psychological (CP) strategies combined (30, 31, 40–43), and 6 used cognitive, behavioral, and psychological (CBP) strategies combined (28, 44–48). The duration of intervention ranged from <1 h (34) to weekly sessions for 18 mo (46); follow-up ranged from immediate (34) to 4 y (38) postintervention.

Outcomes

Of the 24 studies included in the review, 22 (92%) reported learner-based outcomes (**Table 3**), whereas only 13 (54%) reported patient-related outcomes (**Table 4**). A summary of learner- and patient-based outcomes according to training strategy is provided in **Table 5**.

Learner-based outcomes

Nutritional knowledge. Thirteen quantitative studies (25–32, 34–36, 41, 45) and one qualitative study (32) reported data on the nutritional knowledge of health care staff either pre- and post- or postnutrition training. The questionnaires used to assess nutritional knowledge varied widely in the number and types of questions, and only one study (49) used a previously validated nutrition-knowledge questionnaire.

Ten studies reported sufficient quantitative data for inclusion in a meta-analysis (**Figure 2**). Two studies using cognitive training strategies in staff in general practitioner (GP) practices (34) and in care home support staff (32) reported significantly greater knowledge in groups receiving training than in those receiving no training (SMD: 0.76; 95% CI: 0.56, 0.96; $P < 0.00001$) with moderate heterogeneity (I^2 = 41%). One study using cognitive training strategies in nurses in residential care homes (26), reporting results pre- and postintervention, showed no difference

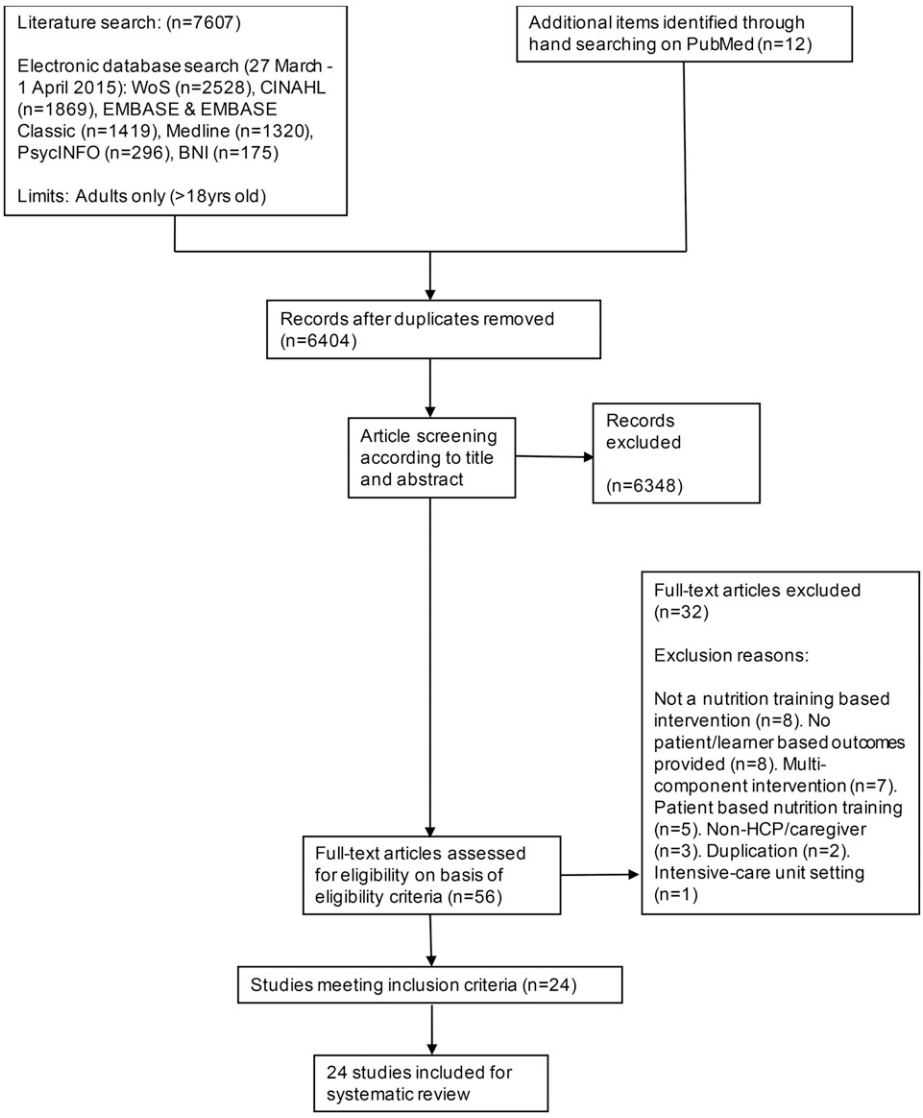

FIGURE 1 Flow diagram of study selection. BNI, British Nursing Index; CINAHL, Cumulative Index to Nursing and Allied Health Literature; HCP, health care professional; WoS, Web of Science.

in knowledge as a result of nutrition training (SMD: 0.31; 95% CI: −0.59,1.21; $P = 0.50$).

Three studies in staff in hospital (29), sheltered-accommodation (27), and GP practices (36), using CB training strategies, reported pre- and postintervention data. A significant improvement was observed in the nutritional knowledge of health care staff who received training (SMD: 1.58; 95% CI: 1.32, 1.84; $P < 0.00001$); however, heterogeneity was high ($I^2 = 89\%$) (Figure 2). Heterogeneity was removed ($I^2 = 0\%$) when one study (31) was excluded from the analysis, and the results remained significant (SMD: 1.93; 95% CI: 1.64, 2.22; $P < 0.00001$).

Two small studies using CP training strategies in physicians in a hospital (30) and the community (31) reported data pre- and postintervention, and no improvement in the nutritional knowledge of physicians was observed after training (SMD: 0.47; 95% CI −0.09, 1.04; $P = 0.10$) with no heterogeneity ($I^2 = 0\%$) (Figure 2).

Two studies using CBP training strategies reported data on health care staff (28, 45). One study reported data as mean differences ± SDs, showing a statistically significant improvement in nutritional knowledge after nursing assistants had received training (SMD: 4.10: 95% CI: 3.24, 4.96; $P < 0.00001$). A very small study in junior doctors reporting results pre- and postintervention found no effect of training (SMD: 0.57; 95% CI: −0.49, −1.63; $P = 0.29$).

In summary, 10 studies reported sufficient data for a meta-analysis of the impact of nutrition training on staff nutrition knowledge. Although there was some evidence that combined training strategies may have a beneficial effect on nutrition knowledge, considerable heterogeneity was observed in the analyses, perhaps in part because of the small sample sizes, the different professions involved, and the variability in the training programs.

Nutritional practice. Eighteen studies reported data on the nutritional practice of health care staff after training, with 9 (50%) reporting statistically significant benefits in favor of training (29–31, 38, 39, 42, 43, 45, 47). A variety of methods was used to measure this outcome: unvalidated staff questionnaires (28, 29, 32, 36, 44, 47); observation (26, 30, 38, 45);

TABLE 2
Key characteristics of studies of nutrition training for health care staff[1]

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Barberger-Gateau et al. (2006) (32)	Nonrandomized controlled trial	—	Home-care support staff Intervention: n = 101 Control: n = 106	2 half-day sessions, 2-mo period, 3-mo follow-up	Cognitive: lectures regarding healthy eating and nutritional management with props and information pack	Staff nutritional-knowledge questionnaire (21 multiple-choice questions), self-reported practice questionnaire (5 questions, binary response), and questionnaire on staff satisfaction with training course Questionnaires developed for the study
Crogan and Evans (2001) (26)	Longitudinal pre-post trial	Nursing home residents, age and number not specified	Nurses Pre: n = 12 Post: n = 8	One 6-h session, 6-mo follow-up	Cognitive: taught evidence-based nutrition-training session including study guides, case studies, and hand-outs	Patient weight loss, number of falls[2] and pressure ulcer incidence,[2] nutritional supplement use Nutritional knowledge questionnaire (15 items) designed to address specific deficiencies in nutritional knowledge identified in a previous trial
Evans and Crogan (2001) (33)	Longitudinal pre-post trial	—	Nursing home nursing assistants and nurses: n = ~140	One 4- to 6-h session, 1-mo follow-up	Cognitive: taught education session designed to refresh staff nutritional knowledge by using a workbook to supplement sessions	Observed mealtime practices (10 potential nutritional problems and 6 dining room practices monitored)
Madigan et al. (2014) (34)	Cluster randomized controlled trial, randomized at nursing-team level	—	GPs (n = 64), district (n = 114) and nursing home nurses (n = 56) Intervention: n = 122 Control: n = 112	Less than 1-h session, immediate postintervention and 6-mo follow-up	Cognitive: lecture with accompanying slides, content based on needs assessment, designed specifically to meet the requirements of health care staff working with tube-fed patients in the community	Health care staff nutritional knowledge based on training resource developed by ASPEN for use with GPs and nurses
Rivière et al. (2001) (25)	Nonrandomized controlled trial	Home-dwelling people with Alzheimer's disease Intervention: n = 151, age = 77.3 ± 8.2[3] y Control: n = 74, age = 75.4 ± 7.9 y	Caregivers Intervention: n = 151 Control: n = 74	Maximum of 9 sessions for caregivers, 1 h each throughout 1 y, 6- and 12-mo follow-ups	Cognitive: didactic presentation by dietitian or health care staff to groups of ~10 people Training included nutritional assessment, management, eating behaviors, and malnutrition	Patient weight, MNA, MMSE, Blandford scale for eating behavior disorders, Katz ADL score, IADL score, Cohen-Mansfield Agitation Inventory, Cornell Mood Scale Caregiver nutritional knowledge questionnaire (27 items, binary response), Zarit Caregiver Burden Scale

(Continued)

TABLE 2 (*Continued*)

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Faxén-Irving et al. (1999) (27)	Nonrandomized controlled trial	Chronically ill residents in sheltered accommodation Intervention: $n = 28$, age = 81.4 ± 7 y Control: $n = 20$, age = 82.1 ± 5 y	Sheltered accommodation staff: $n = 24$	Three 3-h sessions repeated 3 times (time period not specified), 6-mo follow-up	Cognitive: taught nutritional theory regarding nutrition and diet for the elderly Behavioral: practical exercises, calculating BMI, and enriching drinks	Patient BMI, TST, AMC, grip strength, serum albumin, serum hemoglobin, serum insulin-like-growth factor-I, appetite, SGA, MMT, mood (visual analog scale), and Katz ADL score Care staff opinions (6 items) and attitudes to nutrition Nutritional knowledge tested using 3 case studies Questionnaires developed for the study
Faxén-Irving et al. (2005) (35)	Nonrandomized controlled trial	Residents in sheltered accommodation Intervention: $n = 37$, age = 84 ± 7 y Control: $n = 43$, age = 82 ± 7 y	Sheltered accommodation staff Intervention: $n = 25$ Control: $n = 20$	Four 3-h sessions repeated 3 times over a 4-mo period, 5-mo follow-up	Cognitive: lectures regarding nutrition and diet for the elderly provided by dietitians, physicians, and external care staff Behavioral: practical exercises, calculating BMI, and enriching drinks	Patient BMI, TST, AMC, grip strength, serum albumin, serum hemoglobin, serum insulin-like-growth factor-I, appetite, SGA, MMT, mood (visual analog scale), and Katz ADL score Care staff nutritional attitudes and knowledge tested by using a questionnaire developed for a previous study (27)
Kennelly et al. (2010) (36)	Longitudinal pre-post trial	—	GPs and nurses (community, practice, and staff nurses): $n = 96$	One 1- to 3-h session, postintervention and 6-mo follow-up	Cognitive: PowerPoint presentation tailored to each staff group (GPs, nurses, and care home staff) Behavioral: case study practice	Nutritional-knowledge questionnaire (8 multiple-choice questions), self-administered training acceptability questionnaire, self-reported nutritional practice, and dietetic referral rates
Kim and Holme (1981) (37)	Longitudinal pre-post trial	Nursing home residents: $n = 28$, age = 75 y	—	Four 30-min sessions/wk for 4 wk, 1-wk follow-up	Cognitive: taught sessions regarding nutrition for the elderly Behavioral: role-playing sessions to implement learning	Resident intake of energy, protein, calcium, iron, vitamin A, thiamine, riboflavin, niacin, and vitamin C
Olsson et al. (1998) (29)	Longitudinal pre-post trial	Hospitalized patients (geriatric rehab, oncology, internal med, gastro, orthopedic wards): $n = 230$, age = 73–74 y	Nurses: $n = 86$	Training sessions over 3-mo period (frequency not specified), 12-mo follow-up	Cognitive: taught nutritional education and demonstrations to help nurses identify patients a nutritional risk Behavioral: training based on Benner's skill acquisition model, practical demonstrations and discussion concerning nutritional assessment and how to calculate energy intake were provided	Patient energy intake vs. estimated energy requirements (percentage of received energy vs. requirements) Nurses nutritional knowledge, documentation practice, and attitudes to nutrition Questionnaires developed for the study

(Continued)

TABLE 2 (*Continued*)

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Pradignac et al. (2011) (38)	Longitudinal pre-post trial	—	Nurses Intervention: n = not specified Control: n = not specified	1-d session, annual follow-up for 4 y	Cognitive: nutritional education taught by an MDT; this was done alongside the training of a nutritional supervisor Behavioral: "nutritional target" collection (e.g., weight loss and loss of appetite) taught via case studies and discussion	Nutritional practice regarding the routine measurement of patient usual weight, current weight, BMI, height, advice of nutritionist, dietary monitoring, eating independence, food likes and dislikes, feeding assistance, and nutrition risk index
Westergren and Hedin (2010) (39)	Quasi-experimental pre-post trial	Nursing home residents Intervention: n = 4711, age = 86 ± 8.4 y Control: n = 860, age = 85.8 ± 7.7	Kitchen staff, nurses, and nurse assistants: n = 592	Study circle 1 (2005) = 3 sessions, 3 h, 2-y period Study circle 2 (2007) = 3–6 sessions, 2.5–3 h, 3-y period, 2- and 4-y follow-up	Cognitive: study circles aimed at increasing nutritional knowledge Behavioral: practical goal setting via study circles	Prevalence of underweight and overweight patients (defined by BMI), malnutrition risk, and precision of nutritional care (eating assistance, energy-enriched food, and oral nutritional supplements)
Almdal et al. (2003) (40)	Longitudinal pre-post trial	Hospitalized patients (general medicine, orthopedic, and gynecological wards) Nonmalnourished: n = 30, age = 72 ± 7 Malnourished: n = 39, age = 77 ± 9	Physician and nurses, n = 110	One 2-h training session, 4- to 5-mo follow-up	Cognitive: taught sessions regarding hospital food options, energy provision, and nutritional requirement calculations Psychological: hospital nutritional practice group feedback	Patient estimated total energy expenditure ($MJ \cdot d^{-1} \cdot patient^{-1}$) and energy and protein content of food eaten Total energy (MJ/d) and protein (g/d) content of food ordered per patient, waste food returned to kitchen, and net amount available
Bjerrum et al. (2012) (41)	Qualitative pre-post trial	—	Nurses: n = 16	3- to 4-d training program, 1-y follow-up	Cognitive: basic nutritional education designed for nurses responsible for ward nutrition; training curriculum based on experimental learning theories Psychological: feedback on selected observations	Understanding, awareness, approach, and management of clinical nutrition, expectations, and fulfillment of training program
Lazarus et al. (1993) (31)	Longitudinal pre-post trial	Community patients: n = 309, age = 40 ± 15 y	Physicians: n = 14	Sessions over a 6-mo period (frequency not specified), 2-mo follow-up	Cognitive: nutritional-based lecture on nutrition-related disease and healthy eating Psychological: nutrition-specialist observation and nutritional discussion during inpatient rounds	Patient-reported nutrition-related attitudes and events (nutrition- and nonnutrition-related visits) Patient nutrition knowledge Physician nutrition knowledge

(Continued)

TABLE 2 (*Continued*)

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Poisson et al. (2014) (42)	Cross-sectional survey (pre-post trial)	Nursing home resident records Newly admitted residents: pre n = 322, post n = 324 Residents ≥6 mo: pre n = 334, post n = 314 Ages not specified	Nursing home managers, medical director of care, nurses, auxiliary nurses, and cooks Numbers not specified (one of each of the above professions expected to attend from each nursing home, 138 nursing homes participated)	2-day sessions separated by a 6- to 8-mo interval, immediate follow-ups after first and second training days	Based on look, think, act model Cognitive: training day 1 included an education session regarding undernutrition in the elderly and oral health education Psychological: training day 2 included workshops for staff discussion based on the results of the first follow-up	Nursing home institution assessment including bed capacity, weighting equipment, residents' needs, food provision, oral supplement use, texture modification, enriching of foods, night fasting period, and availability of a physical activity program Assessment of records of newly admitted residents including MNA, BMI, weight-loss inquiry, dietary-intake monitoring, mean serum album, diabetes screening, malnutrition risk-factor screening, pressure ulcer examination, dysphagia screening, and oral health Assessment of records for residents ≥6 mo including nutritional status monitoring, oral health, weight loss >5%, undernourished-resident monitoring, dietary-intake monitoring, and provision of nutritional support Assessment of records of residents with a serious event in past 6 mo; outcomes include reason for serious event, malnutrition screening, and malnutrition risk-factor screening
Roubenoff et al. (1987) (30)	Longitudinal pre-post trial	Hospitalized patients Pre and post: n = 34 Mean age = 62 and 60 y, respectively	Physicians: n = 11	Two 2-h sessions, over a 2-d period, 14-d follow-up	Cognitive: taught elements on nutrition assessment and screening tool Psychological: nutritional care plans implemented by staff were followed up by dietitians; adequacy of intervention was then discussed	Patients nutritional risk Physician identification of nutritional risk, nutritional knowledge scores, and number of nutritional consultations, calorie counts, clear liquid meals, and days ONSs were prescribed

(Continued)

TABLE 2 (*Continued*)

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Wikby et al. (2009) (43)	Quasi-experimental pre-post trial	Nursing home residents Intervention: n = 62, age = 85.5 ± 6.1 y Control: n = 53, age = 85.2 ± 6.5 y	Nurses and nurse assistants Intervention: n = 71 Control: n = 102	5 afternoon sessions, 3-mo period, 2-, 4-, and 12-mo follow-up	Cognitive: taught nutrition education with written resources Psychological: discussion of nutritional issues encountered and reflection on how to improve nutritional care	Patient weight index, TST, AMC, mental capacity, motor activity, ADL, MMSE, total activity score, serum albumin and prealbumin Staff meal preparation time
Acuña et al. (2004) (44)	Longitudinal pre-post trial	—	Physicians and nurses: n = 195	Three 4-h sessions, 3-wk period, 3-wk follow-up	Cognitive: nutritional theory learned from literature Behavioral: practice class in evaluating nutritional status Psychological: group discussion regarding nutritional theory and working in an MDT	Questions regarding awareness of nutrition disorders, clinical experience of malnutrition, and evaluation of knowledge developed after training
Chang and Lin (2005) (45)	Quasi-experimental pre-post trial	Nursing home residents with dementia Intervention: n = 20, age = 84.2 ± 4.0 y Control: n = 16, age = 72 ± 5.8 y	Nursing assistants Intervention: n = 31 Control: n = 36	2 sessions (during regular working hours) over a 2-d period, 3-mo follow-up	Cognitive: taught class regarding feeding skills; content included dementia overview, eating assistance, and problem management Behavioral: practical one-on-one sessions Psychological: individual feedback based on practical sessions	Staff knowledge, attitude, and behavior (preparation for residents, environmental preparation, eating encouragement, and feeding skills) Patient total eating time, food intake, and EdFED scale
Dickinson et al. (2008) (46)	Qualitative pre-post trial	—	Health care assistants, nutrition assistants, nurses, occupational therapists, and physiotherapist: n = 19	Weekly 30- to 45-min sessions, 18-mo period, 18-mo follow-up	3-phase look, think, and act protocol Cognitive: taught education sessions Behavioral: role modeling of good practice Psychological: reflective learning via discussion and action planning	MDT and patient responses collated into themes including mealtime care and organization, patient choice, nutritional assessment, mealtime care and nursing priorities, patient choice, assessment of nutritional status, formal assessment of nutritional risk, knowing the patient, working with patients' families, observation and communication of nutritional intake, teamwork, and reflecting together

(Continued)

TABLE 2 (*Continued*)

Study (year) (ref)	Study design	Patient population	Learner population	Training intervention (frequency, duration, and follow-up)	Training strategies	Outcomes
Pedersen et al. (2012) (47)	Longitudinal pre-post trial	Hospitalized patients: pre n = 90, age = 57 ± 14.5 y Control: post n = 88, age = 60.2 ± 12.7 y	Nurses: number specified	6-h sessions, 3- to 4-d period, 12-mo follow-up	Based on experimental learning theories Cognitive: taught nutritional education comprising 5 modules Behavioral: staff participation in the planning phase of nutritional care improvements (including literature searches) Psychological: feedback and discussion based on nutritional practice questionnaire; staff encouraged to reflect on their attitudes toward nutrition	Patient-reported eating difficulties, reporting eating difficulties to staff, not receiving help to cut food, receiving food difficult to chew, not receiving food they had ordered, knowledge about nutrition, and self-reported intake of snacks between meals Staff behavior when offered snacks
Ray et al. (2014) (28)	Longitudinal pre-post trial	—	Junior doctors and medical student: n = 11	2 full-day sessions, over a 2-d period, 1- and 4-mo follow-up	Cognitive: short, taught module on public health and clinical nutrition Behavioral: interactive session and NAW implementation Psychological: targeted teaching based on feedback from questionnaire	MDT hospital malnutrition knowledge, attitudes and practice, and combined weighed average; junior doctor attitude toward hospital malnutrition MDT qualitative feedback regarding training course in general
Suominen et al. (2007) (48)	Longitudinal pre-post trial	Nursing home residents with dementia: n = 21, mean age = 85 y	Nurses and food-service personnel: n = 28	Six 2- to 3-h sessions, 6-mo period, 12-mo follow-up	Cognitive: nutrition education lectures regarding nutritional assessment and management Behavioral: nutrition screening tool practice Psychological: individual feedback and group discussion	Resident energy, protein, and micronutrient intake; BMI; and MNA Staff evaluation regarding most useful method of assessing a residents' nutritional care and qualitative feedback regarding provision of nutritional care

[1] ADL, activities of daily living; AMC, arm muscle circumference; ASPEN, American Society for Parenteral and Enteral Nutrition; EdFED, The Edinburgh Feeding Evaluation in Dementia Questionnaire; GP, general practitioner; IADL, instrumental activity of daily living; MDT, multidisciplinary team; MMSE, Mini–Mental State Examination; MMT, Mini–Mental Test; MNA, Mini–Nutritional Assessment; NAW, nutrition awareness week; ONS, oral nutritional supplement; post, postintervention; pre, preintervention; ref, reference; SGA, subjective global assessment; TST, triceps skinfold thickness.

[2] No reported data.

[3] Mean ± SD (all such values).

TABLE 3
Impact of training strategies on learner-based outcomes (nutritional practice and attitude to nutrition)[1]

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
Barberger-Gateau et al. (2006) (32)	Cognitive	Community, France	Pre and Post questionnaire developed for the study to assess nutritional practice Mean score I post = 4.2 C post = 4.1 (test for difference between scores, $P = 0.22$) Nutrition practice mean difference score I pre vs. I post = 0.22 ± 19 ($P = 0.24$)	—
Crogan and Evans (2001) (26)	Cognitive	Nursing home	Assessed via facilities data on ONS or snack provision I pre and post = no change in practice (data not provided)	—
Evans and Crogan (2001) (33)	Cognitive	Nursing home	1 Pre and 1 post observation of mealtime practices on 10 residents 8/10 mealtime observations reported showed improvement (no test for statistical significance performed)	—
Faxén-Irving et al. (1999) (27)	CB	Sheltered accommodation, Sweden	—	Self-administered questionnaire using VAS (0, low; 10, high) Mean value regarding importance of nutrition for disease treatment Pre = 6.9 Post = 6.9 (NS)
Faxén-Irving et al. (2005) (35)	CB	Sheltered accommodation, Sweden	—	Self-administered questionnaire using VAS (0, low; 10, high) regarding importance of nutrition for disease treatment No I post data provided
Kennelly et al. (2010) (36)	CB	Community, Republic of Ireland	Self-administered I post questionnaire regarding the management of malnutrition practice (open and closed questions) Only I post data provided	—
Olsson et al. (1998) (29)	CB	Hospital, Sweden	Questionnaire to audit use of documentation for assessment of food and fluid intake, number of nurses who documented/total number of nurses Fluid intake Pre = 83/86 Post = 78/85 (NS) Food intake in food forms Pre = 31/86 Post = 58/85 ($P < 0.01$) Food intake in patient records Pre = 28/86 Post = 54/85 ($P < 0.01$) Estimate patient intake and reports verbally Pre = 65/86 Post = 66/85 (NS) No documentation in patient records Pre = 44/86 Post = 22/85 ($P < 0.01$)	Self-administered questionnaire using VAS (0, low; 10, high), mean ± SD Importance of nutritional status to medical perspective Pre = 7.66 ± 1.98 Post = 7.97 ± 1.20 ($P = 0.25$) Nutrition is an important part of medical treatment Pre = 1.96 ± 2.11 Post = 1.57 ± 1.59 ($P = 0.25$) Well-educated nurses in nutrition make it easier to motivate patients to eat and drink (0 = yes, 10 = no) Pre = 3.35 ± 3.49 Post = 2.21 ± 2.33 ($P = 0.01$)

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
			No documentation Pre = 3/86 Post = 1/85 (NS) Does not know where to document patient food intake Pre = 13/86 Post = 9/85 (NS)	
Pradignac et al. (2011) (38)	CB	Hospital, France	Annual questionnaire (completed by a dietitian) regarding routine nutritional variables measured and performed by nursing staff, % Usual weight I = 63.5 C = 53.6 (NS) Current weight I = 80.3 C = 73.1 (NS) Height I = 30.8 C = 12.5 ($P < 0.01$) BMI I = 42.2 C = 19.1 ($P < 0.001$) Nutrition risk index I = 23.3 C = 7.7 ($P < 0.01$) Nutritionist advice I = 33.8 C = 18.5 ($P < 0.05$) Dietary monitoring I = 91.7 C = 60.3 ($P < 0.001$) Eating independence I = 89 C = 70.5 ($P < 0.001$) Food likes and dislikes I = 80.3 C = 61.2 ($P < 0.001$)	—
Westergren and Hedin (2010) (39)	CB	Nursing home, Sweden	Patients (either at risk of malnutrition or normally nourished) judged to be receiving effective nutritional care (effective = correct identification of malnutrition or normally nourished and treatment with oral supplements and protein-energy rich foods), % 2005 Study circle 1 = 45.7 Study circle 2 = 52.5 C = 47.4 ($P = 0.365$)	—

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
			2007 Study circle 1 = 52.6 Study circle 2 = 52.0 C = 45.9 (NS) 2009 Study circle 1 = 53.1 Study circle 2 = 65.2 C = 52.0 (P = 0.006 for C vs. study circle 2) Effective nutritional care to patients at risk of undernutrition, % 2005 Study circle 1 = 18.8 Study circle 2 = 27.8 C = 18.1 (NS) 2007 Study circle 1 = 31.1 Study circle 2 = 28.8 C = 34.6 (P = 0.016 for C vs. study circle 1) 2009 Study circle 1 = 35.6 Study circle 2 = 46.4 C = 30.5 (P = 0.004 for C vs. study circle 2)	
Almdal et al. (2003) (40)	CP	Hospital, Denmark	Mean energy content of food ordered per patient (MJ/d) (calculated from recipe analysis) Pre = 11.1 ± 0.5 Post = 12.1 ± 0.6 (NS)	—
Bjerrum et al. (2012) (41)	CP	Hospital, Denmark	Awareness and practice assessed through semi-structured, Pre and Post focus-group interviews Reported improved nutritional awareness and snack provision	Attitudes toward nutrition assessed through semi-structured, Pre and Post focus-group interviews Nutrition reported as a priority to providing good care after training
Lazarus et al. (1993) (31)	CP	GP practice	Self-administered patient questionnaire relating to physician nutritional care Patients reporting that the physician asked questions about diet and nutrition, assessed as agree or strongly agree, % Overall Pre = 26.2 Post = 39.5 ($P < 0.05$)	—

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
			Nutrition-related visit Pre = 48 Post = 53 (NS) Nonnutrition-related visit Pre = 23 Post = 36 ($P < 0.05$) Physician recommended diet, assessed as agree or strongly agree, % Overall Pre = 20 Post = 33.1 ($P < 0.01$) Nutrition-related visit Pre = 30 Post = 71 ($P < 0.01$) Nonnutrition-related visit Pre = 18 Post = 23 (NS) Patient diet and nutrition questions answered satisfactorily, assessed as agree or strongly agree, % Overall Pre = 88.5 Post = 91.7 (NS) Nutrition-related visit Pre = 50 Post = 100 (NS) Nonnutrition-related visit Pre = 96 Post = 88 (NS)	
Poisson et al. (2014) (42)	CP	Nursing home, France	Audit of 10 randomly selected patient medical records Evidence of any form of malnutrition screening, % Newly admitted residents Pre = 85.4 Post = 91.7 ($P = 0.012$) Residents with a serious event (as defined by infection, stroke, heart failure, hospitalization, pressure ulcer, or other) Pre = 60.4 Post = 81.8 ($P < 0.001$) Malnutrition risk-factor screening (as defined by evidence of screening for dysphagia, pressure ulcers, depression, dementia, mealtime assistance, and behavior trouble), % Residents with a serious event (as defined by infection, stroke, heart failure, hospitalization, pressure ulcer, or other) Pre = 49.7 Post = 66.9 ($P = 0.005$)	—

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
			Evidence of monitoring of nutritional status, % Residents with LoS ≥6 mo Pre = 98.5 Post = 99.4 ($P < 0.001$) MNA completion, % Newly admitted residents Pre = 23.7 Post = 28.4 ($P = 0.17$) BMI completion, % Newly admitted residents Pre = 45.0 Post = 50.9 ($P = 0.13$) Evidence of monitoring of dietary intake, % Newly admitted residents Pre = 65.6 Post = 72.2 ($P = 0.07$) Residents with LoS ≥6 mo Pre = 64.4 Post = 66.7 ($P = 0.837$) Assessment of need for help during meals, % Newly admitted residents Pre = 55.0 Post = 55.6 ($P = 0.88$) Pressure ulcer search, % Newly admitted residents Pre = 39.4 Post = 49.1 ($P = 0.014$) Dysphagia screening, % Newly admitted residents Pre = 33.5 Post = 41.0 ($P = 0.049$) Search for cause of malnutrition, % Resident ≥6 mo Pre = 53.3 Post = 63.9 ($P = 0.345$) Increased human help at mealtimes, % Residents ≥6 mo Pre = 66.7 Post = 77.8 ($P = 0.082$) Proposition of nutritional support Residents ≥6 mo NS changes regarding proposition of enriched foods, ONS, and modified textured foods	

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
			Oral nutritional supplement use, % Pre = 91.3 Post = 95.8 ($P = 0.56$) Mean night fasting period, h Pre = 12.3 ± 0.5 Post = 12.3 ± 0.6 ($P = 0.24$) Possibility of enriched food, % Pre = 43.5 Post = 58.3 ($P = 0.40$) Diet for people with diabetes, % Pre = 79.2 Post = 79.2 ($P = 1$) Weighing equipment provision NS changes Pre and Post	—
Roubenoff et al. (1987) (30)	CP	Hospital	Observation of practice by authors regarding the correct identification of malnutrition risk (as defined by 2 of the following factors being true: weight <20% ideal body weight; weight loss >10%; serum albumin <35 g/L; total lymphocyte count $<1.2 \times 10^9$/L; presence of ≥3 historic risk factors including vomiting, anorexia, dysphagia, food allergy or change in stool color), % Pre = 12.5 Post = 100 ($P < 0.001$) Observed nutrition consultations, *n* Pre = 0 Post = 12 ($P = 0.005$) Observed energy counting, *n* Pre = 2 Post = 7 (NS) Observed days taking ONSs, *n* Pre = 18.6 Post = 27 (NS)	—
Wikby et al. (2009) (43)	CP	Nursing home, Sweden	Nurse estimation of time to prepare meals at baseline and 1 y after I, min Breakfast Pre = 3.6 Post = 2.9 ($P < 0.05$) Lunch Pre = 4.4 Post = 3.4 ($P < 0.05$) Dinner Pre = 4.2 Post = 2.9 ($P < 0.01$)	—

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
Acuña et al. (2004) (44)	CBP	Hospital, Brazil	Self-administered questionnaire using a Likert scale to assess incorporation of learning into medical professional practice post training Pre = data not collected Post = 100% answered yes	Self-administered questionnaire using a Likert scale to assess attitudes toward nutrition post training Nutritional concern for patients Pre = data not collected Post = 100% "very much" increased concern Motivation in prevention of malnutrition Pre = data not collected Post = 100% "very much" increased motivation
Chang and Lin (2005) (45)	CBP	Nursing home, Taiwan	Assessed using the Formal Behaviors toward Feeding Dementia Patients observation checklist Mean ± SD score (1 = behavior of nursing assistant observed, 0 = not observed) I Post = 0.57 ± 0.15 C Post = 0.28 ± 0.006 ($P < 0.05$)	Assessed using Formal Caregivers' Attitude toward Feeding Dementia Patient questionnaire (Likert-scale) Mean ± SD attitude score (a higher score indicates more negative attitude) I Post = 44.0 ± 8.6 C Post = 49.0 ± 12 ($P = 0.001$)
Dickinson et al. (2008) (46)	CBP	Hospital, United Kingdom	Assessed using focus groups with thematic analysis Mealtime practice Staff described mealtimes as less chaotic, and improved nutritional assessment documentation was noted Formal assessment of nutrition risk Staff described MUST as complicated to use and unhelpful	Health care staff nutritional attitudes assessed using focus groups with thematic analysis Staff described nutritional care as a priority and recognized the importance of being involved in mealtimes
Pedersen et al. (2012) (47)	CBP	Hospital, Denmark	Assessed using a validated questionnaire about feeding difficulties and snack provision, completed by patients, % (95% CI) Patients not receiving help in cutting their food Pre = 8.1 (4.3, 18.7) Post = 0 (0, 6.5) ($P = 0.014$) Patients receiving food difficult to chew Pre = 11.6 (5.7, 20.4) Post = 1.3 (0, 7.4) ($P = 0.010$) Patients not receiving food they had ordered Pre = 10.7 (5.7, 18.7) Post = 1.3 (0, 7.4) ($P = 0.010$) Patients offered snacks between meals daily or nearly daily Pre = 45.5 Post = 63.8 ($P = 0.000$)	—

(Continued)

TABLE 3 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Nutritional practice	Attitude to nutrition
Ray et al. (2014) (28)	CBP	Hospital, United Kingdom	Validated 20-item questionnaire regarding knowledge, attitudes, and practice designed for this study administered via online survey (practice-related case study questions), % Practice score Pre = 89 Post 1 mo = 95 (NS) Post 4 mo = 97 (NS)	Validated 20-item questionnaire regarding knowledge, attitudes, and practice designed for this study administered via online survey (attitude related questions), % Attitude score Pre = 78 Post 1 mo = 80 (NS) Post 4 mo = 78 (NS)

[1] C, control; CB, cognitive and behavioral; CBP, cognitive, behavioral, and psychological; CP, cognitive and psychological; GP, general practitioner; I, intervention; LoS, length of stay; MNA, Mini–Nutritional Assessment; MUST, Malnutrition Universal Screening Tool; ONS, oral nutritional support; Post, postintervention; Pre, pre-intervention; ref, reference; VAS, visual analog scale.

patient record audits (31, 39, 42); focus groups (41, 46); facilities data, i.e., parameters usually tracked by long-term facilities such as weight loss, falls, pressure sores, and use of supplements and snacks (26); food energy content (40), and meal preparation time (43).

The 3 studies using cognitive training strategies found no effect of training on nutrition practice in home-care support staff (32) and nurses and nursing assistants in nursing homes (26, 33). Results of studies using a combination of training strategies were more inconsistent. Three of the 4 studies using CB training strategies reported a significant improvement in the nutritional care provided by nursing home assistants (39) and nutrition-related documentation by nurses in hospital (29, 38). Four of the 6 studies using CP strategies reported significant beneficial effects on a range of outcomes related to nutrition practice in nursing home nurses (42, 43), GPs (31), and hospital physicians (30). Two of the 5 studies using CBP strategies reported significant improvements in nutritional care practice. In one study (47) snack provision and reported eating difficulties improved significantly in hospitalized patients after staff training. In the other study (45) the nutritional behavior of nursing assistants improved after training. Although a qualitative study in hospital-based HCPs reported training had improved nutritional assessment documentation and the mealtime environment (46), 2 quantitative studies in a similar population (39, 47) reported that nutrition training had no effect on practice scores or on the incorporation of learning into practice. In summary, the impact of training on the nutritional practice of health care staff was inconsistent, perhaps in part reflecting the variety of methods used to measure this outcome. In studies in which a combination of training strategies was used, however, some improvements in nutritional practice were observed.

Attitude to nutrition. Six quantitative (27–29, 35, 44, 45) and 2 qualitative (41, 46) studies reported data on the attitude of learners toward nutrition after training. A variety of methods was used to measure this outcome: focus groups (41, 46), unvalidated self-administered questionnaires using visual analog scales (27, 29, 35), Likert scales (44, 45), and multiple-choice questions (28). Two quantitative studies reported statistically significant effects in favor of staff training in residential care (45) and in the hospital (29). With the use of thematic analysis to code and interpret the focus group discussions, the 2 qualitative studies reported that after training hospital staff viewed nutrition as a priority in providing effective patient care (41, 46).

No studies using cognitive training strategies alone reported data on this outcome. Results of studies using a combination of training strategies were inconsistent. One of 3 studies using CB training (29) reported that more nurses agreed that being well educated in nutrition made it easier to motivate patients to eat and drink (P = 0.01); however, there was no improvement in the other 2 attitude-based outcomes (Table 4). Two studies using CBP training strategies in hospital staff reported no improvements in attitude toward nutrition postintervention (28, 44). In contrast, a study in nursing assistants in residential care reported significant improvements in attitude toward nutrition in the intervention group when compared with the control group (45). In summary, the impact of training on the attitude of health care staff toward nutrition was inconsistent; however, in the 5 studies that reported sufficient data on both nutritional practice and attitudes (28, 29, 41, 45, 46), improvements in practice only occurred

TABLE 4
Impact of training strategies on patient-based outcomes[1]

Study (year) (ref)	Training strategy	Setting	Weight and body composition	Nutritional intake	Prevalence of malnutrition	Physical function	Cognitive function
Crogan and Evans (2001) (26)	Cognitive	Nursing home	Proportion of patients with weight loss, % Pre = 12 Post = 8 (NS)	—	—	—	—
Rivière et al. (2001) (25)	Cognitive	Free living, France	Change in weight (adjusted for MNA, caregiver age, Cornell and Blandford), 0–12 mo, kg I = 0.6 ± 0.4[2] C = −0.6 ± 0.6 (NS)	—	Change in MNA (adjusted) 0–12 mo I = 0.2 ± 0.2 C = −0.4 ± 0.3 (NS)	—	Change in MMSE (adjusted) 0–12 mo I = −2.3 ± 0.3 C = −3.4 ± 0.5 ($P < 0.05$)
Faxén-Irving et al. (1999) (27)	CB	Sheltered accommodation, Sweden	BMI, kg/m^2 Men Pre = 26.6 ± 3.1 Post = 27.0 ± 3.4 ($P < 0.05$) Women Pre = 25.6 ± 3.2 Post = 25.4 ± 3.4 (NS) AMC, cm Men Pre = 26.4 ± 2.0 Post = 26.5 ± 1.8 (NS) Women Pre = 21.7 ± 2.9 Post = 22.0 ± 3.3 (NS) TST, mm Men Pre = 10.5 ± 2.3 Post = 10.0 ± 2.6 (NS) Women Pre = 22.5 ± 10.4 Post = 22.5 ± 10.6 (NS)	—	SGA, *n* Well nourished Pre = 23 Post = 22 (NS) Possible malnutrition Pre = 1 Post = 2 (NS) Serious malnutrition Pre = 2 Post = 1 (NS)	ADL Pre = independent Post = independent (NS) Handgrip, kg Men Pre = 37.2 ± 5.1 Post = 36.6 ± 5.1 (NS) Women Pre = 16.3 ± 4 Post = 15.1 ± 5.4 (NS)	MMT score Pre = 24.2 ± 3.2 Post = 24.9 ± 3.2 (NS)
Faxén-Irving et al. (2005) (35)	CB	Sheltered accommodation, Sweden	Weight, kg 0–5 mo I post = 65.5 ± 19.1 C post = 62 ± 12.7 (NS) BMI, kg/m^2 0–5 mo Men I post = 28.4 ± 6.1 C post = 23.4 ± 3.5 (NS) Women I post = 24.2 ± 5.3 C post = 23.8 ± 4.8 (NS)	—	SGA 0–5 mo, % Well nourished I post = 69 C post = 73 ($P < 0.05$) Possible malnutrition I post = 28 C post = 17% ($P < 0.05$) Serious malnutrition I post = 3 C post = 10% ($P < 0.05$)	Mean ADL (25th–75th percentile) I post = B (A–E) C post = A (A–B) (NS) Handgrip, kg Men I post = 24.5 ± 9.1 C post = 32.8 ± 8.5 ($P < 0.05$) Women I post = 10.5 ± 6.3 C post = 19.7 ± 4.3 ($P < 0.05$)	MMSE score I post = 21.3 ± 6.0 C post = 24.1 ± 5.3 (NS)

(Continued)

TABLE 4 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Weight and body composition	Nutritional intake	Prevalence of malnutrition	Physical function	Cognitive function
Kim and Holme (1981) (37)	CB	Nursing home	—	Mean energy intake, kcal Men and women: Pre = 1600 Post = 1828 ($P < 0.05$)	—	—	—
Olsson et al. (1998) (29)	CB	Hospital, Sweden	—	Energy intake vs. requirements, average difference, kcal Pre = −600 Post = −434 ($P < 0.02$)	—	—	—
Westergren and Hedin (2010) (39)	CB	Nursing home, Sweden	Underweight prevalence (study circle second period), % 2005 I = 30.3 C = 29.9 ($P = 0.929$) 2007 I = 17.7 C = 30.2 ($P = 0.008$) 2009 I = 15.6 C = 27.7 ($P = 0.028$)	—	—	—	—
Wikby et al. (2009) (43)	CP	Nursing home, Sweden	Weight index after 4 mo, % I = 97.2 ± 15.2 C = 93.9 ± 14.7 ($P = 0.241$) TST after 4 mo, mm I = 13.1 ± 5.3 C = 12.1 ± 5.6 ($P = 0.311$) AMC after 4 mo, cm I = 23.6 ± 2.8 C = 22.9 ± 2.3 ($P = 0.156$)	—	PEM prevalence after 4 mo, *n* I at baseline = 20 I at 4 mo = 7 ($P = 0.004$)	Median ADL score I at 4 mo = 29 C at 4 mo = 24 ($P = 0.035$) I at baseline = 27 I at 4 mo = 29 ($P = 0.583$) Median motor activity after 4 mo (6–24) I = 24 C = 20 ($P = 0.016$) Total activity score after 4 mo (16–92) I = 79 C = 70 ($P = 0.011$)	Median MMSE score after 4 mo I = 19 C = 11 ($P = 0.029$)
Poisson et al. (2014) (42)	CP	Nursing home, France	—	—	Weight loss >5% or other diagnosis of undernutrition, % Residents ≥6 mo Pre = 13.5 Post = 11.5 (NS)	—	—
Roubenoff et al. (1987) (30)	CP	Hospital	—	—	Patients at nutritional risk, % Pre = 47 Post = 41 (NS)	—	—

(Continued)

TABLE 4 (*Continued*)

Study (year) (ref)	Training strategy	Setting	Weight and body composition	Nutritional intake	Prevalence of malnutrition	Physical function	Cognitive function
Chang and Lin (2005) (45)	CBP	Nursing home, Taiwan	—	Food eaten, % I post = 0.85 ± 0.25 C post = 0.94 ± 0.18 ($P = 0.49$)	—	—	—
Pedersen et al. (2012) (47)	CBP	Hospital, Denmark	—	Daily or nearly daily snack intake, % In the afternoon Pre = 33.3 Post = 63.8 ($P \leq 0.05$) In the evening Pre = 32.5 Post = 56.4 ($P = 0.004$)	—	—	—
Suominen et al. (2007) (48)	CBP	Nursing home, Finland	Mean BMI, kg/m^2 Pre = 21.7 Post = 21.4 (NS)	Mean energy intake, kcal Pre = 1230 Post = 1487 ($P < 0.001$) Energy intake <1200 kcal, % Pre = 43 Post = 10 ($P = 0.005$) Energy intake 1200–1570 kcal, % Pre = 57 Post = 57 (NS) Energy intake >1570 kcal, % Pre = 0 Post = 29 (NS)	MNA, % Not at risk of malnutrition Pre = 0 Post = 16 ($P = 0.10$) At risk of malnutrition Pre = 89 Post = 63 (NS) Malnourished Pre = 11 Post = 21 (NS)	—	—

[1] ADL, activities of daily living; A–G, independent to totally dependent; AMC, arm muscle circumference; C, control; CB, cognitive and behavioral; CBP, cognitive, behavioral, and psychological; CP, cognitive and psychological; I, intervention; MMSE, Mini–Mental State Exam; MMT, Mini–Mental Test; MNA, Mini–Nutritional Assessment; PEM, protein energy malnutrition; Post, postintervention; Pre, pre-intervention; ref, reference; SGA, subjective global assessment; TST, triceps skinfold thickness.

[2] Mean ± SD (all such values).

TABLE 5
Summary of learner- and patient-based outcomes according to training strategy (quantitative studies only)[1]

Outcome	Number of studies showing statistically significant improvement	Type of training strategy			
		Cognitive (n = 5)	Cognitive behavioral (n = 7)	Cognitive psychological (n = 6)	Cognitive behavioral psychological (n = 6)
Learner-based outcomes (n = 22 studies)					
Nutritional knowledge	10/13 (77)	3/4 (75)	4/4 (100)	2/3 (67)	1/2 (50)
Nutrition practice	9/16 (56)	0/3 (0)	3/4 (75)	4/5 (80)	2/4 (50)
Attitude to nutrition	2/6 (33)	—	1/3 (33)	—	1/3 (33)
Patient-based outcomes (n = 13 studies)					
Weight and body composition	2/7 (33)	0/2 (0)	2/3 (67)	0/1 (0)	0/1 (0)
Nutritional intake	4/5 (80)	—	2/2 (100)	—	2/3 (67)
Prevalence of malnutrition	2/7 (29)	0/1 (0)	1/2 (50)	1/3 (33)	0/1 (0)
Physical function	1/3 (33)	—	0/2 (0)	1/1 (100)	—
Cognitive function	2/4 (25)	1/1 (100)	0/2 (0)	1/1 (100)	—

[1] Values are n/N (%).

alongside a more positive attitude toward nutrition (29, 41, 45, 46). Furthermore, this outcome was often poorly measured, with only 2 studies (28, 45) using a validated attitude questionnaire.

Patient-based outcomes

Nutritional intake. Five of 24 (21%) studies reported data on patient or resident nutritional intake (29, 37, 45, 47, 48) with 4 studies reporting statistically significant benefits in favor of staff training. No studies using cognitive training strategies alone reported data on this outcome. In the 2 studies using CB training strategies there was a significant increase in mean energy intake (287 kcal, $P < 0.05$) (37) and a reduced deficit between energy intake and estimated requirements in hospital patients after staff training ($P < 0.02$) (29). Two of the 3 studies using CBP training strategies found significant improvements in patient or resident nutritional intake. In the study by Pedersen et al. (47) a significant increase in afternoon ($P < 0.05$) and evening ($P = 0.0004$) snack intake was reported. In a study in nursing home staff (48), training was associated with a reduction in the number of patients consuming <1200 kcal/d (43% compared with 10%, $P = 0.005$) and a significant difference in overall energy intake between groups (Table 4); however, no significant difference was noted in the number of patients consuming >1200 kcal/d postintervention. A study of training of nursing assistants in residential care reported no difference in resident intake between intervention and control groups (45). In summary, 4 of the 5 studies reporting on this outcome found evidence to suggest staff nutrition training, with the use of a combination of strategies, may result in improved nutritional intake in patients or residents.

Weight and body composition. Seven of 24 studies (29%) reported data on patient body weight. Three studies reported a statistically significant improvement in body weight associated with staff training (27, 39, 43), whereas the remainder found no effect of training (25, 26, 35, 48) (Table 4).

Two studies of cognitive training strategies (25, 26) and 1 of CBP training strategies (48) reported no changes to body weight in either group. Two of 3 studies using CB training strategies found modest but statistically significant improvement in male BMI (in kg/m^2: 0.4; $P < 0.05$) (27) and a reduction in the prevalence of underweight in chronically ill residents in sheltered accommodation (39). A study using CP training strategies in nurses in a residential care home reported no difference in weight index between residents in the intervention and control groups; however, within-group changes were statistically significant in both groups in the 2007 and 2009 cohorts (43).

Two studies reported data on body composition. One study using CP training strategies in nurses working in residential care showed a statistically significant beneficial effect on TST but no improvements in AMC (43) (Table 4). A study using CB training strategies in sheltered accommodation staff found no improvements in AMC and TST in residents (27). In summary, only 3 of the 7 studies reporting this outcome found significant improvement with beneficial effect found only in studies utilizing CB strategies.

Prevalence of malnutrition. Seven of 24 studies (29%) examined the impact of staff training on the prevalence of malnutrition. Two studies showed a significant beneficial effect of the intervention (35, 43). One study of cognitive training strategies

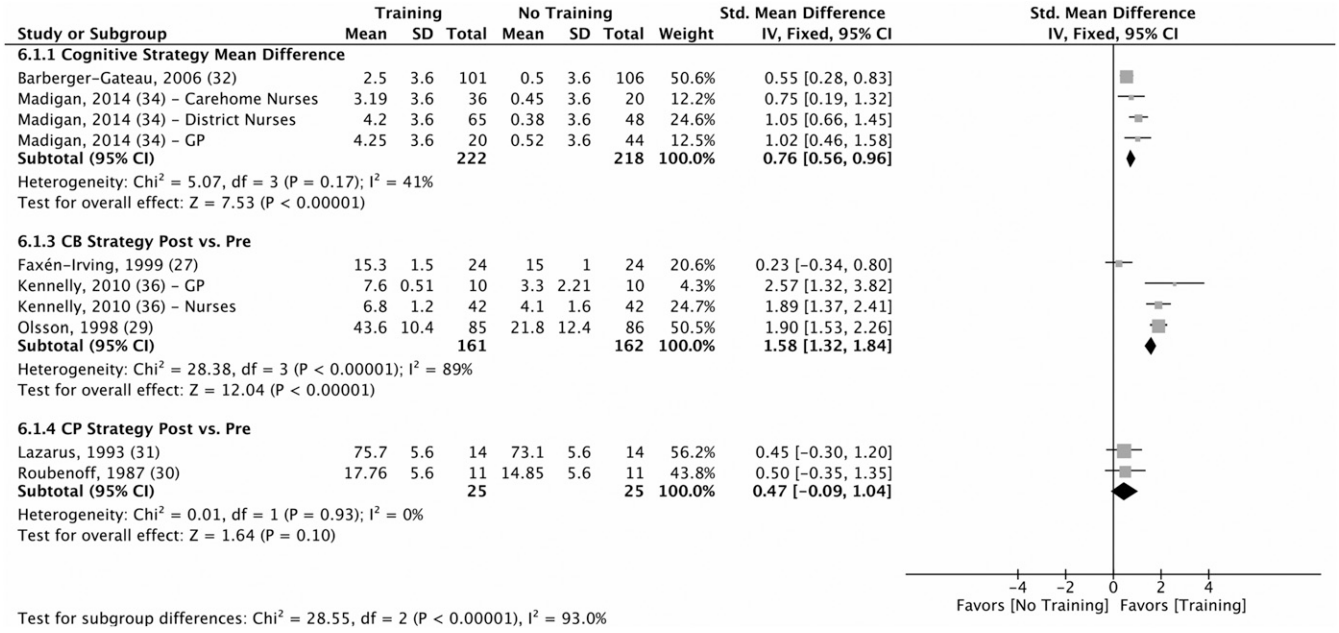

FIGURE 2 Health care staff nutritional knowledge according to training strategy. CB, cognitive and behavioral training; CP, cognitive and psychological training; GP, general practitioner; IV, inverse variance.

in those who provided care for people with Alzheimer disease (25) and another using CBP strategies in nursing home staff (48) reported no statistically significant changes in group MNA scores or numbers of malnourished residents. One of 2 studies using a CB training strategy reported no significant within-group changes in the numbers of malnourished patients but reported a significant between-group improvement in subjective global assessment classification associated with the intervention (35) (Table 4). One of 3 studies using CP training strategies reported a significantly lower prevalence of malnutrition in the intervention group (43). Two similar studies reported no difference between groups in indicators of malnutrition (30, 42). In summary, 5 of the 7 studies reporting this outcome showed no beneficial effect of the intervention regardless of training strategy.

Physical and cognitive function. Three studies (31, 48, 50) reported data on the impact of staff training on resident physical function. Both studies using CB training strategies found no improvement in handgrip strength or activities of daily living (ADL) in either group of residents in sheltered accommodation (27, 35). Furthermore, Faxén-Irving et al. (35) showed a small but statistically significant reduction in handgrip strength in both male and female participants in the intervention groups (Table 4). A study using CP training strategies (43) demonstrated significant improvements in the intervention group in total activity ($P = 0.011$), motor activity ($P = 0.016$), and ADL ($P = 0.035$) when compared with the control group; however, the scores for total activity and ADL were significantly higher in the intervention group at baseline.

Four studies (25, 27, 35, 43) reported data on cognitive function, 2 of which reported beneficial effects of training on MMSE scores in care home residents (43) and home-dwelling people with Alzheimer disease (25). One study using cognitive training strategies showed significantly less deterioration in MMSE scores in the intervention group than in the control group (25) (Table 4). Two studies using CB training strategies found no significant difference in MMSE scores between groups (27, 35). One study using CP training strategies (43) reported a significant improvement in MMSE scores in patients in the intervention group after 4 mo and significantly higher scores in the intervention group than in the control group. In summary, few studies reported on the impact of staff nutrition training on physical and cognitive outcomes, and the results were inconsistent between studies.

Quality of studies and risk of bias

Of the 24 studies included, 1 was an RCT (34), 4 NRCTs (25, 27, 32, 35), 3 quasi-experimental trials (39, 43, 45), 13 longitudinal pre-post trials (26, 28–31, 33, 36–38, 40, 44, 47, 48), 2 qualitative studies (41, 46), and 1 a cross-sectional survey (37). The risk of bias assessment is shown in **Figure 3**.

No studies were considered to be at low risk of bias. Only 2 studies (34, 45) used a method of randomization and allocation concealment; however, insufficient information regarding the process (34) made the level of selection bias unclear. High risk of performance bias was identified in the majority of studies because of the unavoidable staff awareness of the training intervention. Owing to inadequate reporting, detection bias was often unclear; however, objective outcomes, such as knowledge test results, patient weight, body composition, and malnutrition prevalence, were deemed low risk (22). The risk of attrition bias was deemed low or unclear in the majority of studies as explanations, such as staff job changes and scheduling difficulties, were unlikely to be linked to the study intervention and outcomes (22). A high risk of attrition bias was identified in 2 studies because of high participant dropout rates, lack of explanation (32), and the exclusion of specific health care staff groups (44). In studies with no information on missing data or insufficient detail in the methods, the risk of reporting bias (22) was categorized as high or unclear.

The authors of this review identified incomplete reporting of nutritional knowledge (25, 27, 28, 30–32, 34, 35), practice (36, 44), and attitude (44) outcome data. High risks of other sources of bias were identified because of statistically significant baseline differences between control and intervention groups (25, 32, 35, 39) and the use of unvalidated questionnaires in all but one of the 13 studies that assessed the nutritional knowledge of health care staff.

The author of one article (26) was contacted seeking clarification on tests of statistical significance; however, no further useful data or information was provided after the request.

A potential conflict of interest was identified in 2 studies (28, 46); however, it was noted that in 1 (28), the authors designed and conducted the study independently of the funders.

DISCUSSION

The aims of the present systematic review and meta-analysis were to evaluate the impact of nutrition training for health care staff on learner- and patient-based outcomes and to assess the effectiveness of different training strategies. The overall finding of this review was that nutrition training may improve nutrition knowledge, practice, and attitudes of health care staff in acute and community settings. This finding, however, comes from poor-quality evidence with a high risk of bias. Perhaps surprisingly, the impact on patient-based outcomes was examined in only ~50% (13 of 24) of the studies. A beneficial effect was observed in 4 of the 5 studies reporting data on nutritional intake; however, the results for other outcomes (prevalence of malnutrition, weight and body composition, and functional status) were inconsistent. To our knowledge, the present review is the first to categorize and analyze nutrition training according to training strategy. There were too few studies measuring the same outcome in each training strategy for firm conclusions to be drawn on the efficacy of any specific training strategy over the others; however, this review suggests that a combination of strategies is more likely to be effective than cognitive strategies alone.

In this review, learner and patient outcomes were measured by using a wide variety of methods (including the use of unvalidated questionnaires) at different time points after staff training, and it is therefore difficult to draw firm conclusions from the results. Interestingly, in the few studies that reported data on both nutritional practice and attitudes (28, 29, 41, 45, 46), improvements in staff practice only occurred alongside a more positive attitude to nutrition (29, 41, 45, 46). This suggests that improvement in the attitude of health care staff toward nutrition may result in more determined and comprehensive staff actions to address malnutrition (41); however, this may not always be the case (49). Factors such as care setting, quality of educational input, training duration, and learner receptivity were not formally analyzed in this review (and rarely reported in the included studies) despite evidence suggesting they may affect training efficacy (18, 51). In the present review, the duration of training sessions varied widely from <1 h (46) to 4 full-day sessions (41) and frequency ranged from a one-off session (26, 33, 36, 38, 40) to 18 mo of weekly training (46). Furthermore, patient outcomes were assessed at different time points ranging from 1 wk (37) to ≤4 y (38, 39) after staff training. The data reported in the included studies were too disparate in their presentation for formal analysis of the impact of these variations in duration, intensity, frequency, and length of follow-up on learner and patient outcomes. Because of high staff turnover, repeated training sessions may be required to contribute to improved nutritional care (27, 36). In practice, nutrition training may also need to be implemented alongside clinical processes, such as routine nutrition screening, to support the management of malnutrition on a systematic level (50, 52, 53).

The results of the current review are consistent with the findings of others (8, 10, 16, 18) in this area in that there is a lack of evidence of either effectiveness or ineffectiveness of staff nutrition training interventions. In a review assessing the impact of interventions to indirectly support food and drink intake in people with dementia, Abdelhamid et al. (12) reported that the training interventions were too small and/or short-term for any definitive conclusions to be drawn regarding effectiveness. Similarly, in a review evaluating the impact of mealtime interventions for elderly patients living in residential care, Abbott et al. (14) found that there were insufficient data for a meta-analysis of the impact of staff training on patient nutritional status or intake. The current review highlights the need for more robust research on the impact of nutrition training on learner and, in particular, patient outcomes. Although it might be expected that staff training in nutrition should result in improved nutritional practice, there is a high discordance between nutritional and clinical outcomes (54), and it should not be assumed, for example, that the beneficial effects of training on the nutritional knowledge of health care staff or patient nutritional intake result in improved clinical outcomes (54).

The unique contributions of this review are *1*) the categorization of studies by the training strategies used and *2*) the attempt to explore the impact of different training strategies on learner- and patient-based outcomes. Training strategies vary widely in format and effectiveness, and without analysis of the training strategies used, the interpretation of the impact of different staff training interventions is limited (24). It is clear that cognitive (passive) strategies, such as didactic lectures and the dissemination of printed material, are less effective than behavioral or psychological (active) strategies, such as interactive workshops and performance feedback (16, 55), and the results of the present review are consistent with this view. Interestingly, none of the studies using psychological strategies measured the impact on staff self-efficacy, sense of control, motivation, or empowerment, all of which are explicit aims of psychological training strategies (24).

A strength of this review is the wide range of electronic databases (n = 6) searched, with no limits set to language or publication date; however, it is possible citations not collated electronically may have been missed (56). Training strategies may have been miscategorized because of author interpretations; however, this risk was minimized by consultation with co-authors. The gray literature was not searched, and although there was an absence of duplicate study selection, this was ameliorated by duplicate data extraction. To undertake a meta-analysis of the impact of training on nutrition knowledge, it was necessary to make some assumptions about data, as well as imputing SDs for change. Using imputed SDs allowed valuable combination of data permitting tentative effects on nutrition knowledge to be surmised; however, the use of this latter technique has been criticized (23). These are limitations of the review and are potential sources of bias. All study

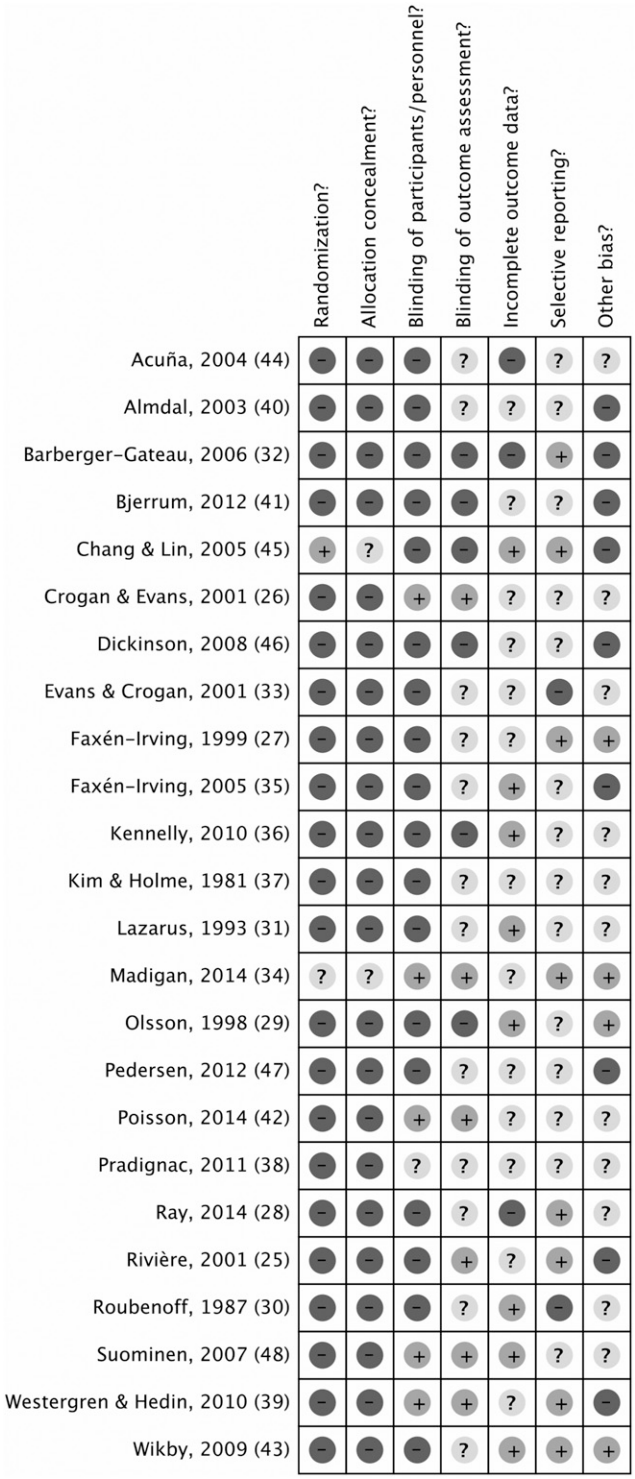

FIGURE 3 Bias table (Review Manager v5.3).

designs were eligible for inclusion, resulting in the inclusion of a large number of poorer-quality studies. Although it is acknowledged that NRCTs are prone to selection and allocation bias (57), they can provide valid (58) and valuable data in the absence of RCTs (59).

To improve the evidence base, future studies should adopt a theory-driven approach to justify the training methodology used (24) and should be rigorous in design and of sufficient sample size and duration to fully evaluate the impact of different training strategies on learner- and patient-based outcomes. The published protocol of Arija et al. (60) represents the type of research required in this area because it proposes the use of computer-assigned randomization, a standardized and explicit approach to education, validated outcome measures, 12-mo follow-up, and a large sample size (n = 200).

This review summarized the findings for 24 studies, suggesting some beneficial effects on the nutritional knowledge, practice, and attitudes of health care staff and patient nutritional intake. Because of the lack of good-quality evidence and considerable discordance in results, there is a need for well-designed RCTs to confirm the impact of different approaches to nutrition training for health care staff.

The authors' responsibilities were as follows—OM and CB: designed the research; OM: conducted the research, provided the essential materials, and wrote the manuscript; CEW: had primary responsibility for the final content; and all authors: analyzed the data, performed the statistical analysis, reviewed the manuscript, and read and approved the final manuscript. None of the authors reported a conflict of interest related to the study. CEW is funded by a National Institute for Health Research (NIHR) Clinical Academic Training Fellowship. This review presents independent research funded by the NIHR. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health.

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